Space Weather Technical Forecast

Issued on Wednesday 13 November 2024 at 01:24 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: R1/R2 Likely throughout. Chance of Active to G1/Minor Geomagnetic Storm intervals, mainly Day 1 (13 Nov).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity measured by GOES18 at L1 has been Low over the past 24 hours, with a peak of C8.2 at 12/1401 UTC from just beyond the northwest limb. AR3889, near centre disc, and AR3884 in the southwest have been the main sources of other C-class flare activity through the period.

There are currently seven sunspot regions on the disc, all of which lie in the southern hemisphere. The largest and most complex region on the disc remains AR3889, with up to two delta spots contributing to its overall Fki/Beta-Gamma-Delta classification. AR3383, close to the southwest limb, has decreased in size and complexity over the past 24-hours. The other regions are relatively small and simple in comparison.

An impulsive filament eruption was ongoing at the start of 12 Nov, with a subsequent, and more significant filament eruption around 12/1400 UTC. Both of which are largely directed limbward, and are expected to miss Earth.

As such, no CMEs observed over the past 24-hours are considered to have an Earth-directed component.

Solar Wind / Geomagnetic Activity: Solar winds at L1 measured by ACE were indicative of a slow regime. The solar wind speed fell from initial values of around 400 km/s to 340km/s. Density was predominantly below average and within single figures ppcc. The interplanetary magnetic field (IMF) was weak and steady with a peak of 6nT. The north-south component, Bz, varied erratically between +/-5nT, and has largely been southward oriented. The phi angle was mainly positive (away from the Sun), but with brief periods of negative (towards the Sun) values.

The net result of the above solar wind measures was for Quiet (Kp 1-2) geomagnetic activity throughout.

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 remained at Background levels.

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High energy electron flux (greater than 2MeV) observed by GOES16 was initially at Background, increasing to Moderate levels around 12/0900 UTC, peaking at 506pfu at 12/2040 UTC. The associated 24-hour fluence has been on a slight upward trend, but remains below the Active threshold. The 1.58e7 integrated flux observed at 13/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Isolated M-class flares are Likely throughout the period, with a Slight Chance of X-class flares, most likely from AR3889.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs currently feature in the forecast.

Connection to a coronal hole fast wind is expected during Day 1 (13 Nov) with enhancement to wind speeds expected to then persist for much of the period. Largely Quiet to Unsettled (Kp 0-3) geomagnetic activity forecast, with chance of Active to G1/Minor Geomagnetic Storm intervals (Kp 4-5), mainly on Day 1, as a result of coronal hole enhancement.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 is at Background levels. There is a very slight rising trend in the probability of S1/Minor solar radiation storms, mainly due to the potential for significant flares from AR3889 as it rotates into a potentially more geoeffective position in the western hemisphere.

The high energy electron flux is anticipated to rise to diurnal peaks at High levels during the period, with the associated fluence most likely persisting below Active levels.

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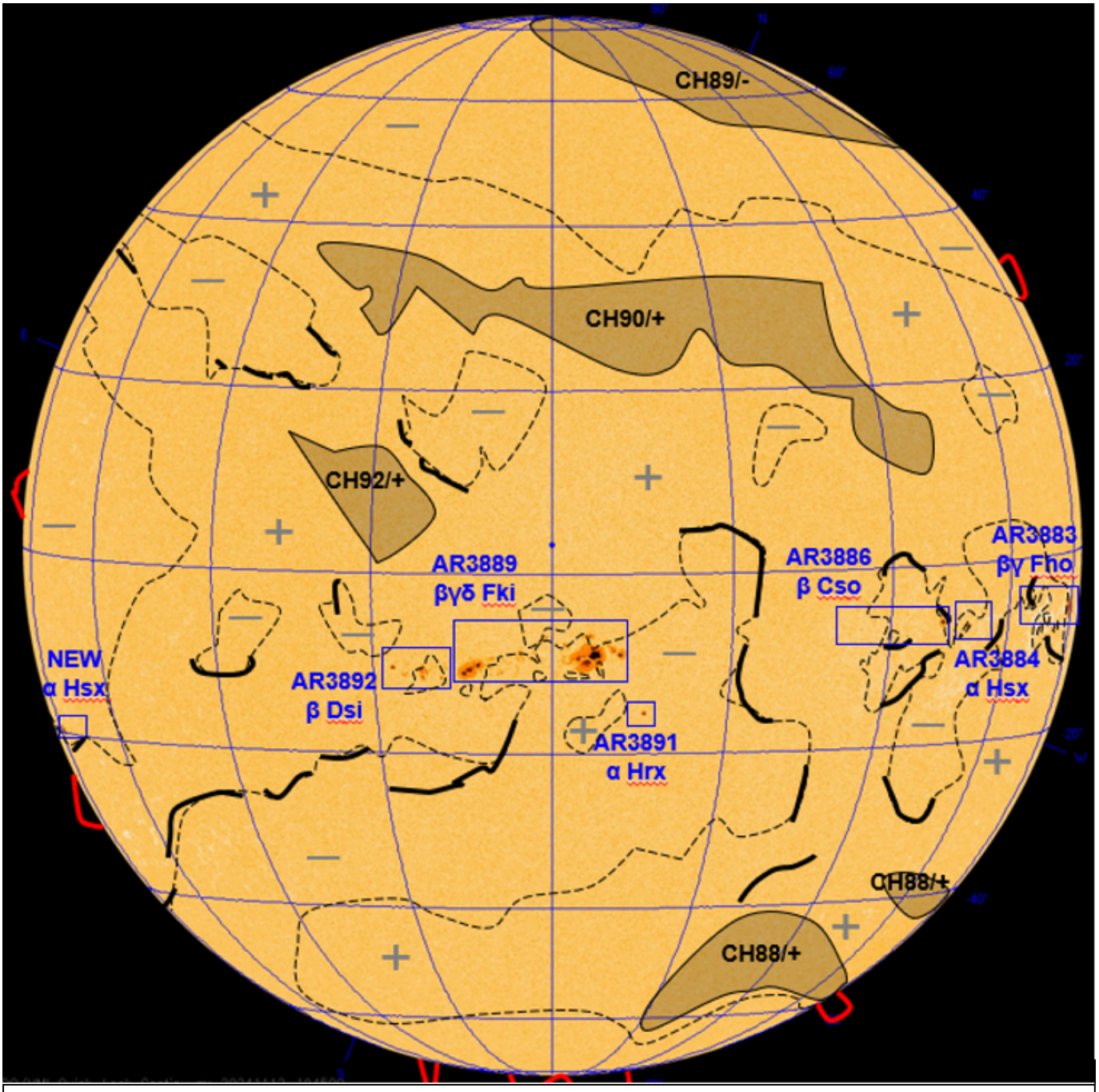
Figure 1: Solar Synoptic map, valid 12/2000 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

No Earth-directed CMEs currently feature in the forecast, with observed filament eruptions close to the western limb in recent days not projected to have Earth-directed components. One filament lift-off from the southern hemisphere on 11 Nov produced a CME around 11/1630 UTC which is expected to pass behind Earth. However, a small number of Enlil ensemble members suggest some glancing enhancement on Day 2 (14 Nov) attributed to this event. There are a number of filaments which have shown signs of movement and warrant monitoring for potential sources of CMEs during the period.

The four-day forecast comprises primarily of coronal hole influences. Connection to a HSS from CH90/+ is expected during Day 1 (13 Nov) with some element of enhancement persisting through much of the forecast period. CH90/+ is in a similar position to the previous rotation, but extends further east and slightly further south. Solar winds reached 450-500km/s on the previous rotation, with SWPM supporting similar speeds during Day 1. MOSWOC Enlil is providing reasonable guidance for the start of the period, however it does not suggest a significant connection to CH90/+ which is being discounted given the coronal hole's position on the disc, and as such confidence in Enlil is low through the period. Connection to a HSS from CH92/+ is possible towards the end of Day 4 (16 Nov), with CH92/+ currently located on the eastern disc.

Geomagnetic activity is expected to be largely Quiet to Unsettled (Kp 0-3) through the period. On Day 1 (12 Nov), Unsettled to Active (Kp 3-4) conditions are expected at times with a chance of G1/Minor Geomagnetic Storm intervals (Kp 5) following connection to the HSS. During Days 2-4 (14-16) there remains a slight chance of further G1/Minor Geomagnetic Storm intervals owing to the feature's longitudinal extent.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	10	10	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Figure 2: MOSWOC Enlil, considered to be underestimating CH90/+ enhancement to wind speeds.

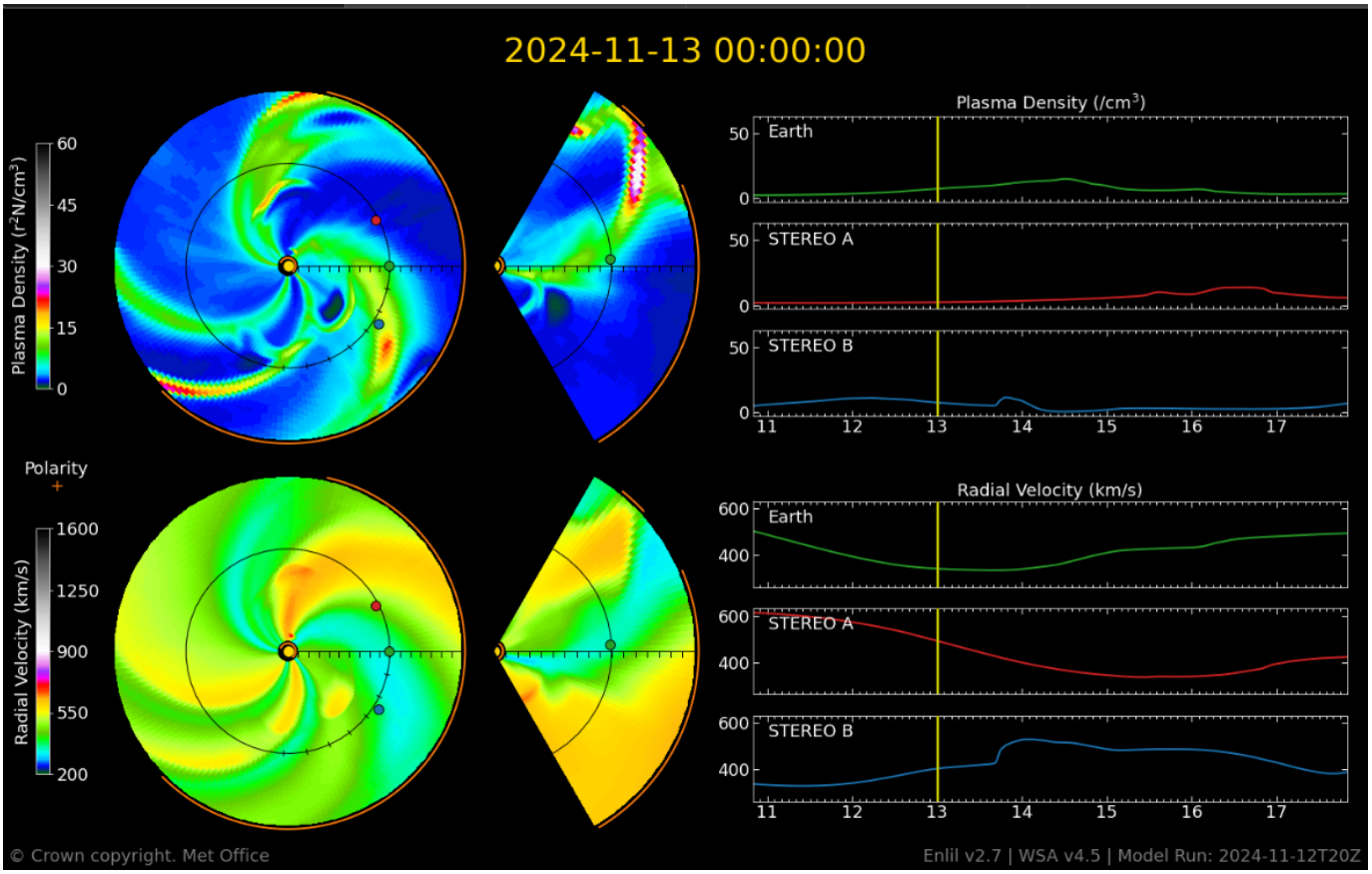

Figure 3: MOSWOC Enlil Ensemble showing suggestions of enhancement on 14 Nov associated with a filament lift-off and CME on 11 Nov.

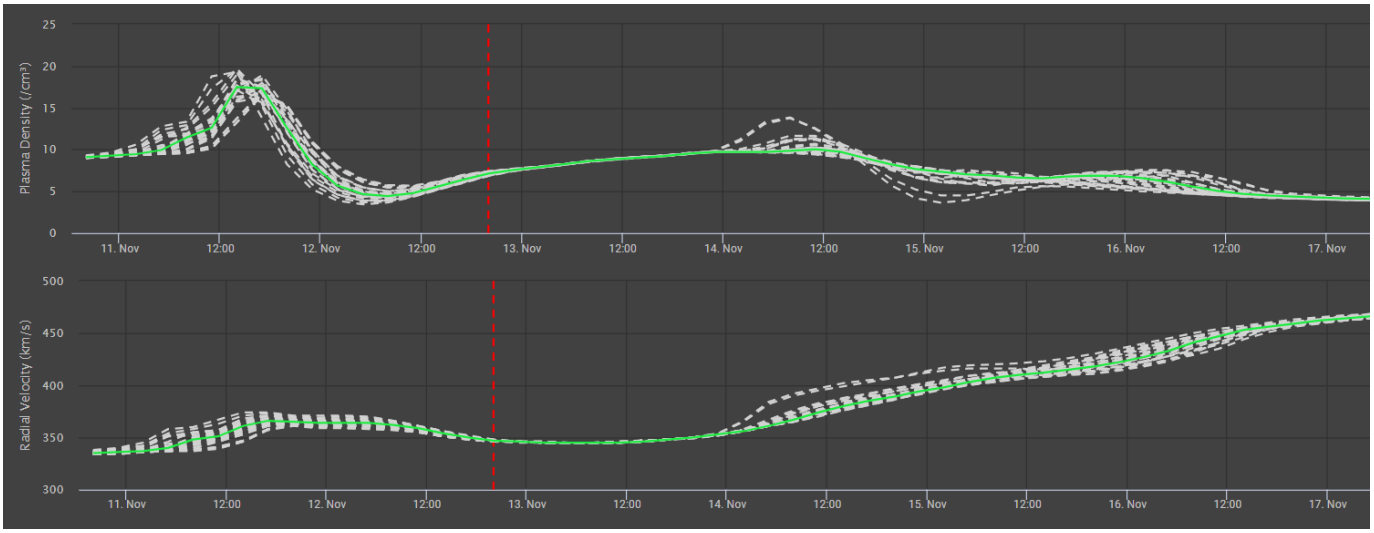

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Figure 4: MOSWOC SWPM considered to be giving a reasonable steer during 13-14 Nov following anticipated connection to a HSS from CH90/+.

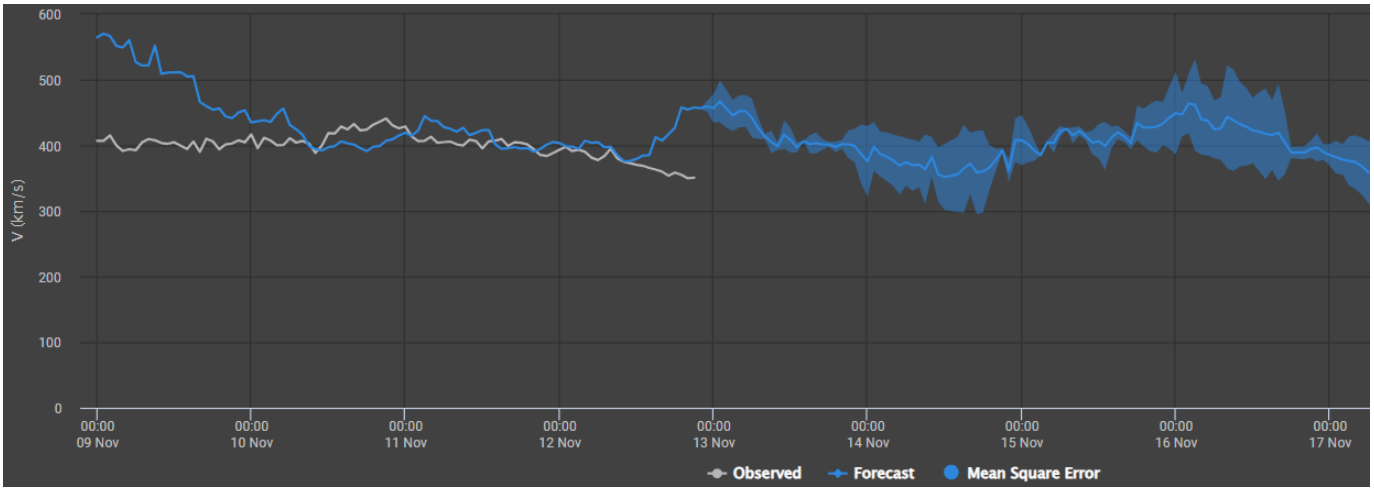

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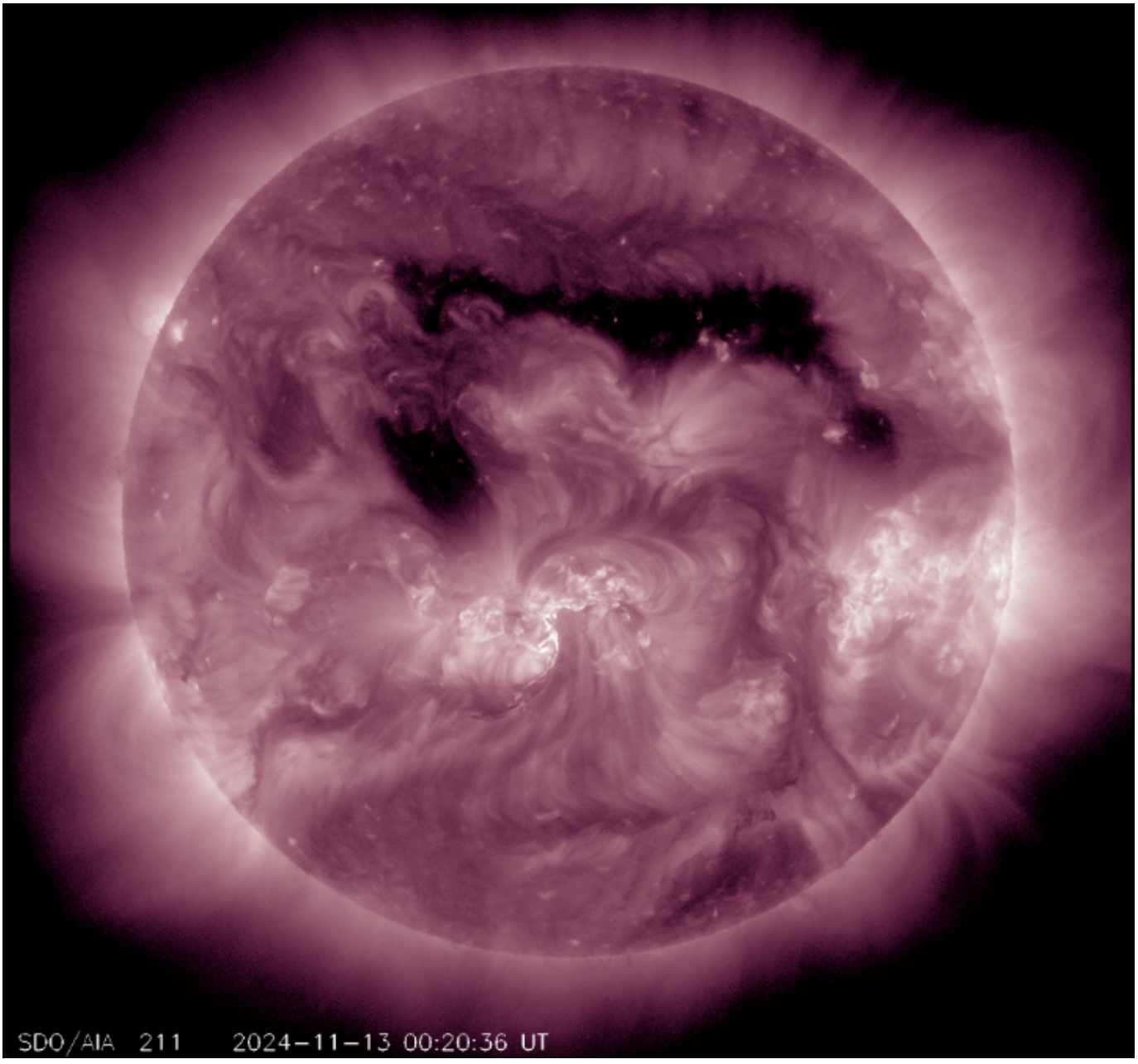
Figure 5: SDO/AIA-211 imagery showing the pronounced coronal holes in the northern hemisphere.



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Radio Blackouts - X-Ray Flares

Solar activity fell to Low in the period, with occasional C-class flares observed, mainly from AR3889 near centre disc and AR3884 in the southwest. The peak flare during 12 Nov originated from just beyond the western limb following a filament disruption.

There are seven sunspot regions on the visible disc. The largest and most complex region on the disc is AR3889 (Fki/Beta-Gamma-Delta), situated across the solar meridian and in the southern hemisphere. This sunspot group contains a number of mature spots with at least two small delta regions in the lead group. AR3883 (Fho/Beta-Gamma), in the southwest, is becoming more difficult to analyse as it approaches the west limb, although has shown some signs of growth and decay in the faint trailing portion. It retains its classification at this moment, but has tended towards a Cho region as the spots in the trailing portion are much weaker and less mature than the lead portion. The remaining regions are stable and magnetically simple.

AR3883 is due to depart the disc during Days 2-3 (14-15 Nov), but the daily risk of significant flares is maintained due to contributions from AR3889 as it rotates westward, and the potential for flaring activity from AR3883 after it has departed the disc.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	70	70	70	70
Very Active	R3-R5 (X Class)	No	10	10	10	10

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Figure 6: GOES16 and GOES18 X-Ray irradiance trace over 12 Nov.

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Solar Radiation Storms (High Energy Protons)

High energy proton flux at GOES18 is at Background levels and is forecast to remain as such during the period in the absence of any significant flare activity.

There is a very slight rising Slight Chance of S1/Minor solar radiation storms over the period, mainly due to any significant flares from AR3889 as it rotates into a more geoeffective position in the western hemisphere.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) as observed by GOES16 is at Normal Background to Moderate levels.

Persistence-wise, Earth is now approaching a period where spells of High flux are likely, with diurnal highs at High levels achieved during the last rotation of what is now CH90/+. 24-hour fluence levels are expected to remain below Active levels with MOSWOC REFM considered to be offering reasonable guidance.

Overall, in the absence of any CME arrivals, there is a rising slight chance of Active fluence, peaking later in the period after geomagnetic activity subsides from the onset of CH90.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	10	10
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 7: GOES18 Electron Flux trace.

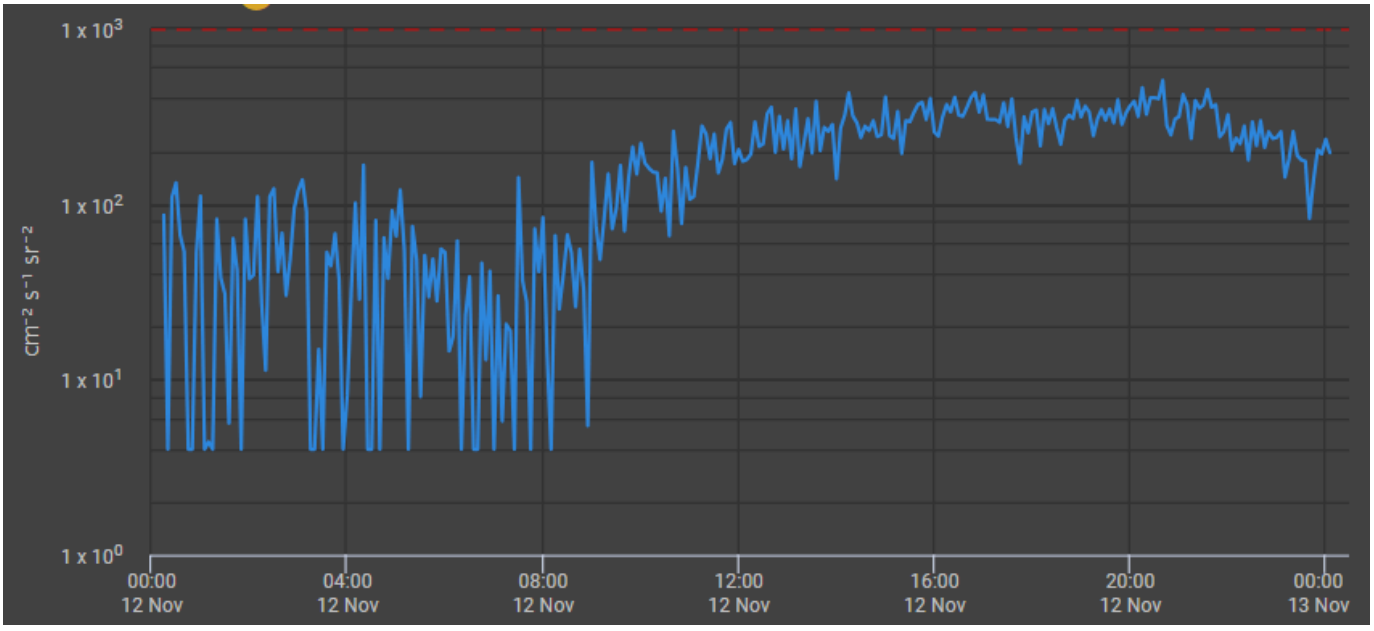

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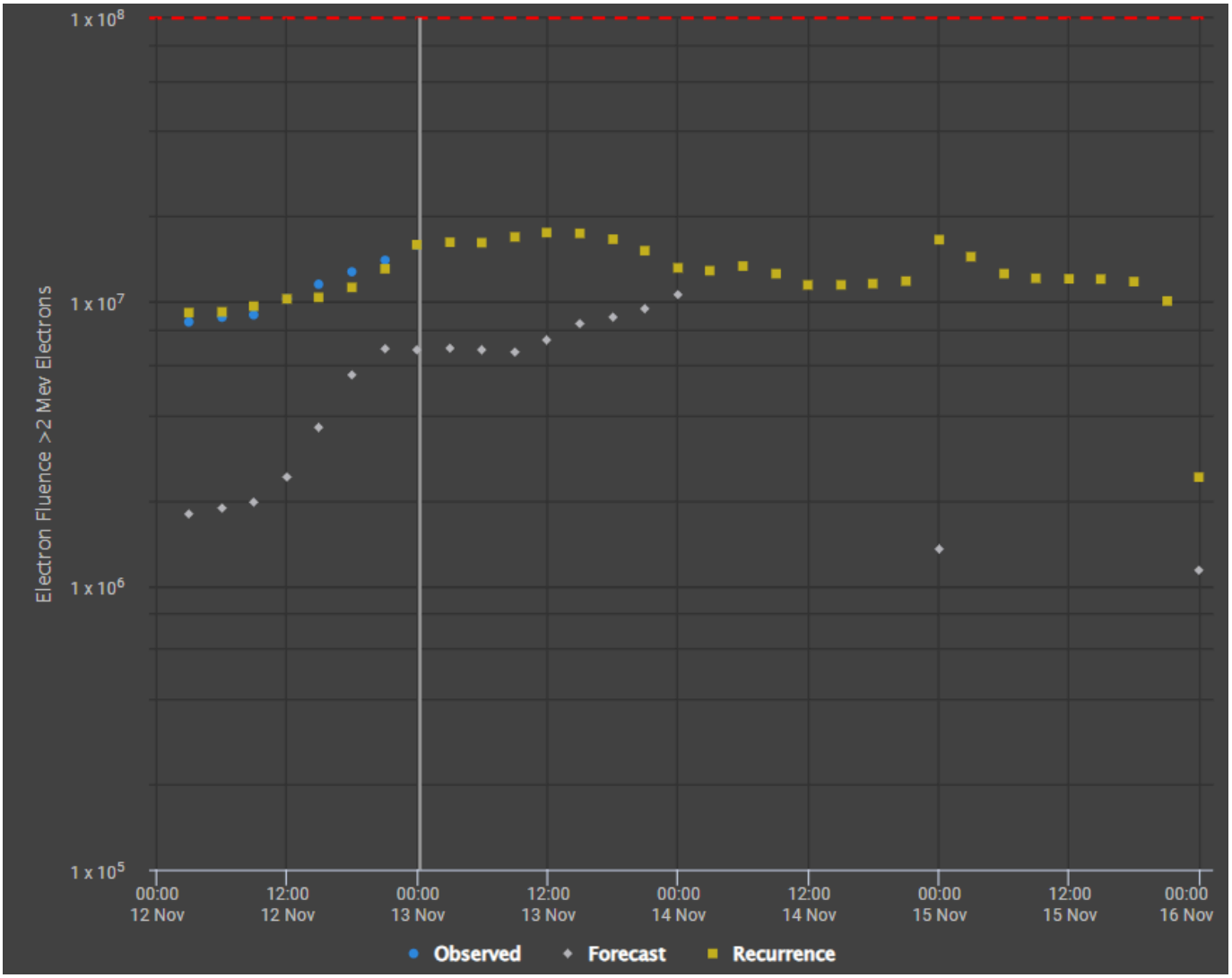
Figure 8: MOSWOC REFM considered to be giving good guidance.



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